137-1958-2-2338

A New Method for the Study of the Equilibrium (cont.)

method was used to determine at various temperatures the distribution of P between a low-carbon Fe and a slag consisting of 33.6% CaO, 2.1% Na_2O, 28.4% Al_2O_3, 4.6% SiO_2, 1.8% MgO, 25.0% FeO, 6.3% Fe_2O_3, and 2.1% P_2O_5. The results obtained are quite accurately stated by the equation:

$$\log K_P = \log \frac{(\% P)}{[\% P]} = \frac{16,000}{T} - 6.94$$

K_P was determined from the ratio of the counting rate of an original slag sample to the counting rate of a metal sample taken after equilibrium had been attained. This method was used also to determine the distribution of S between Fe and slags consisting of: 1) 50% CaO and 50% Al_2O_3; 2) 45% CaO, 45% Al_2O_3, and 10% MnO. In both cases the heat flow from the Fe to the slag was nearly 40 kcal/gram atom.

I.T.

1. Metal slag systems--Application 2. Equilibrium--Test methods
3. Equilibrium--Test results

Card 2/2

137-1958-2-2345

CHVARTSMAN, L. A.

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 2, p 20 (USSR)

AUTHORS: Shvartsman, L.A., Tomilin, I.A., Travin, O.V., Popov, I.A.

TITLE: The Effect of the Oxides of Alkaline Earth Metals on the Distribution of Sulfur Between Iron and Ferruginous Slag (Vliyaniye okislov shchelochnozemel'nykh metallov na raspredeleniye sery mezhdu zhelezom i zhelezistym shlakom)

PERIODICAL: V sb.: Fiz.-khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 304-318. Diskus., pp 332-334

ABSTRACT: The radioactive isotope S^{35} was used to study the dependence on the temperature of the distribution of S between Fe and a slag consisting of Fe oxides. The results are described by the equation

$$\log K_s = \left(\frac{3000}{T}\right) - 1.05 ,$$

wherein K_s is the coefficient of distribution of S, computed as the ratio of the counting rate from the slag to the counting rate from the metal, the counting rates being computed by the thick-layer method. The MgO content of the ferruginous slag, so long as it did not exceed 7.76%, exhibited no influence either on the K_s value

Card 1/2

137-1958-2-2345

The Effect of the Oxides of Alkaline-Earth Metals (cont)

or on its dependence on temperature. With the maximum precision attainable in the experiment it was found that the CaO content, up to 12%, likewise did not alter the K_s value. For ferruginous slag containing more than 12% CaO it was learned that

$$\log K_s = \left(\frac{3700}{T}\right) - 1.26.$$

This equation is correct for a CaO content up to 33%. The small-ness of the effect exerted by the CaO on the K value is accounted for by the increase that occurred in the Fe_2O_3 concentration when CaO was introduced into the slag. For a slag containing 11.5 - 16.2% BaO, the equation obtained was $\log K_s = (3200/T) - 0.99$. From the dependence on temperature of K_s a computation was made of the heat effect of the desulfurization of the Fe by a slag consisting only of Fe oxides + 14 kcal/gram.atom, with addition of more than 12% CaO + 17 kcal/gram.atom and 11-16% BaO + 14 kcal/gram.atom. The smallness of the heat effect and the smallness of the difference between them when one oxide was substituted for another are accoun-ted for by the absence in ferruginous slags of any specific chemical reaction of oxides of Ca, Ba, and Mg with S.   I.T.

Card 2/2

1. Sulfur--Distribution   2. Iron--Applications   3. Slag--Appli-cations   4. Alkaline earths--Oxidation--Effects

SHVARTSMAN, L.A.

137-1958-1-223

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 1, p 34 (USSR)

AUTHORS: Travin, O.V., Shvartsman, L.A.

TITLE: Kinetics of Sulfur Transport from Pig Iron Into a CaO-Al$_2$O$_3$ Type Slag (Kinetika perenosa sery iz chuguna v shlak sistemy CaO-Al$_2$O$_3$)

PERIODICAL: V sb.: Fiz.-khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 319-331. Diskus. pp 332-334

ABSTRACT: In the light of the results obtained and the concepts of electro-chemistry, the Authors suggest the following mechanism for the transfer of S from iron to slag: $[S] + 2e \rightleftarrows (S^{--})$ $[Fe] \rightleftarrows (Fe^{++}) + 2e$ (1) and $[Fe] + [S] \rightleftarrows (Fe^{++}) + (S^{--})$ (2). If the Fe contains deoxidizing elements, reaction (1) may be competing with other processes also making for adherence to the conditions of electrical neutrality, for example. $[C] + (O^{--}) \rightarrow CO_{gas} + 2e$; $[Si] + 2(O^{--}) \rightleftarrows (SiO_2) + 2e$; $(O^{--}) \rightleftarrows [O] + 2e$. On the assumption that the limiting stage of the entire process of desulfuration is the molecular transport of the S ion into the slag via the diffusion layer on the boundary with the metal, the A's derive the following kinetic equation:

$$d[\%S] / dt = D A \cdot k [\%S] p / \delta,$$

Card 1/2

137-1958-1-223

Kinetics of Sulfur Transport From Pig Iron (cont.)

where D is the coefficient of diffusion of S, k is the mass transport coefficient, and δ is the effective thickness of the diffusion layer. It was found that the rate of desulfuration is proportional to the concentration of S in the iron, with the exponent subject to temperature variations. When the temperature is low, the exponent is close to unity and the reaction is monomolecular. At higher temperatures, the order of reaction is fractional and tends toward 2. See RzhMet, 1956, Nr 2, 1000.

I.P.

1. Iron--Purification   2. Iron--Processing--Desulfurization
3. Electrochemistry--Applications

Card 2/2

137-58-4-6566

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 4, p 36 (USSR)

AUTHORS: Malkin, V. I., Shvartsman, L. A.

TITLE: Measuring the Ion Transference (Hittorf) Number of the Ca^{2+} in Fused $CaO-P_2O_5$ (Izmereniye chisla perenosa iona Ca^{2+} v rasplave $CaO-P_2O_5$)

PERIODICAL: V sb. Fiz.-khim. osnovy proiz-va stali. Moscow, AN SSSR, 1957, pp 433-437. Diskus. pp 505-512

ABSTRACT: The following method was used to measure the ion trans-ference numbers in oxide melts. A small corundum-coated crucible, having a 1-1.5 mm aperture at its bottom, was placed in a large-diameter crucible of the same materials. The slag (27% CaO, 73% P_2O_5) was charged into the cruc-ibles and weighed. The slag contained Ca^{45}. Graphite elec-trodes were lowered into the melt on attainment of $1000^{\circ}C$ temperature. After current had been passed through it, the electrodes were removed and the crucible weighed with its diaphragm and contents. The loss of weight in the course of the experiment was determined in this way. Then the crucible was broken, and the weights of the catholyte and anolyte were

Card 1/2

Measuring the Ion Transference (cont.)

determined separately. The Hittorf number x_1 of the Ca ion through the anodic space was calculated from the equation:

$$x_1 = \frac{p \cdot q_f}{K \cdot E_1} \quad \left(1 - \frac{I_f}{I_i} + \frac{q_a}{q_f} \right) ,$$

where q_f was the weight of the anolyte after the experiment, q_a was the weight loss of the anolyte during the experiment, I_i and I_f were the radio-activities of the anolyte before and after the experiment, p was the weight percentage of the Ca^{2+} ion before the experiment, K was the quantity of electricity in farads, and E_1 was the numerical value of a gram-equivalent of the Ca^{2+} ion. Here q_a was computed from the equation $q_a = K (E_1 + E_2) x_1$, where E_2 was the numerical value of a gram-equivalent of the O^{2-} ion. Four experiments yielded the following values of x_1: 1.06, 1.04, 1.06, 1.02. These data show that the conductivity of the melt is by a single cation.

I.K.

1 Metallurgy   2. Melts--Applications   3 Ion exchange--Measurement

Card 2/2

SHVARTSMAN, AOS. L.A.

Measurement of transference numbers in molten oxide mixtures. V. I. Malkin, S. P. Khokhlov, and L. A. Shvartsman (Central Iron and Steel Research Inst., Moscow). *Intern. J. Appl. Radiation and Isotopes* 2, 19-25 (1957)(in English).—The transference nos. of Na^+ and Ca^{++} were measured in $CaO \cdot P_2O_5$, $Na_2O \cdot 2SiO_2$, $Na_2O \cdot CaO \cdot 4SiO_2$, and $CaO \cdot Al_2O_3 \cdot SiO_2$ with Na^{24} and Ca^{45} as tracers. The advantage is that small changes of compn., which obviate side effects and side reactions, can be measured in the anolyte; the amt. of electricity passed through the soln. does not exceed 0.03 Faraday. The transference no. of the cation in the binary systems is nearly unity, whereas Na^+ is much more mobile than is Ca^{++} in the ternary oxide; practically the total current is carried by the cations. In the system $CaO \cdot Al_2O_3 \cdot SiO_2$, Al^{+++} competes with Ca^{++}. The method permits study of the relation between charges and dimensions of cations and their mobility in oxide melts. — Walter G. Rothschild.

OSIPOV, A.I.; SHVARTSMAN, L.A.; ALEKSEYEV, V.I.; SUROV, V.F.;
  SAZONOV, M.L.; BUL'SKIY, M.T.; TELESOV, S.A.; SKREBTSOV,
  A.M.; OFENGENDEN, A.M.; GOL'DSHTEYN, L.G.; SVIRIDENKO, F.F.

Radioisotope studies of scrap fusion kinetics and slag formation
in the scrap-ore process. Atom.energ. 3 no.10:352-355 O '57.
(MIRA 10:10)
  (Steel--Metallurgy) (Radioisotopes--Industrial applications)

SHVARTSMAN, L.H.

AUTHORS: Tomilin, I.A., Khokhlov, S.F. and Shvartsman, L.A. (Moscow).   24-4-28/34

TITLE: Influence of admixtures of calcium and sodium oxides on the distribution of the sulphur between the iron and the acidic slag. (Vliyaniye dobavok okislov kal'tsiya i natriya na raspredeleniye sery mezhdu zhelezom i kislym shlakom).

PERIODICAL: "Izv. Ak. Nauk, Otd. Tekh. Nauk" (Bulletin of the Ac. Sc., Technical Sciences Section), 1957, No.4, pp.152-156 (USSR).

ABSTRACT:
In a previous paper (Izv. Ak. Nauk, Otd. Tekh. Nauk, 1953, No.12) the authors studied the distribution of sulphur between the iron and the acidic slag consisting of a melt of iron oxides which were saturated with silica. In this paper the results are described of studies of the influence on this equilibrium of additions of calcium and sodium oxides to the acidic slag. The used technique was described earlier (1) and (2). The slag was first smelted and the mixture for smelting was prepared from chemically pure iron oxide and quartz powder to which a certain quantity of calcium and sodium carbonate were added. The investigations were carried out by means of the radio-active isotope S^{35}. The curves of self-absorption were also measured for a slag consisting of iron oxides and a slag of a complex composition containing about 20% Na_2O, about 30% iron oxides and about 50% SiO_2; the results of these measurements are given in Fig.1. The results of the tests

Card 1/2

Influence of admixtures of calcium and sodium oxides on
the distribution of the sulphur between the iron and the
acidic slag. (Cont.).   24-4-26/34

in which the equilibrium was studied are given in the
Tables 2 and 3 and in the graphs 2 and 3. The heat of
transition of the sulphur from the iron into the slag
of the system $FeO-SiO_2$ which is saturated with silica,
decreases if calcium oxide is added to the slag. For a
calcium concentration of about 20% the reaction heat
amounts to about 13 000 cal/g-atom, which almost corres-
ponds to the heat of transfer of the sulphur from the iron
into the ferrous slag. In addition, an increase in the
CaO concentration in the slag brings about some increase
in the entropy of the FeS. The overall result of these
processes is a decrease of the sulphur distribution co-
efficients compared to the acidic slag not containing CaO.
Introduction of Na_2O into the investigated slag causes
the same phenomena to a still more intensive degree. These
phenomena are attributed to the specific interaction of
the ions in the acidic melt. There are 3 figures, 3 tables,
8 references, 7 of which are Russian.

Card 2/2

ASSOCIATION: Institute of Metallography and Metal Physics, TsNIIChM.

SUBMITTED: July 17, 1956.

AVAILABLE:

SOV/137-58-10-20933

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 10, p 80 (USSR)

AUTHOR: Shvartsman, L.A.

TITLE: Employment of Induction Heating for Normalization of Butt-welded Seams of Drill and Exploratory Casings (Primeneniye induktsionnogo nagreva dlya normalizatsii stykosvarnykh shvov buril'nykh i geologorazvedochnykh trub)

PERIODICAL: Novosti neft. tekhn. Neftepromysl. delo. 1957, Nr 12, pp 26-27

ABSTRACT: A description is presented of a more productive method of normalizing welded seams of drill casings outside the clamps of welders by induction heating with standard-frequency current. Employment of high-frequency current (2500-8000 cps) is also effective as a method of normalizing welded seams of large-diameter drill casings.

V.O.

1. Pipes--Welding   2. Seam welds--Heat treatment
3. Induction heating--Applications

Card 1/1

SHVARTSMAN, L. A.

DYKHNE, A.M., inzhener; OSIPOV, A.I.; SHVARTSMAN, L.A.; IUDIN, V.Ye.

Formula for calculating the time for the equalization of the composition of the bath in open-hearth furnaces. Zav. lab. 23 no.4:506-507 '57.   (MLRA 10:6)

1. Kuznetskiy metallurgicheskiy kombinat (for Dykhne).
                (Open-hearth process)

SHVARTSMAN, L. A.

4
4E2c

13473* (Russian.) Acid-Base Properties of Metallurgical
Slags Kislotno-osnovnye svoistva metallurgicheskikh shla-
kov. L. A. Shvartsman and L. A. Tomilin. *Uspekhi Khimii*,
v. 26, May 1957, p. 554-567.
Study of acid-base properties of oxides and their mixtures.

RG
PM up

SHVARTSMAN, L.A.; TOMILIN, I.A.

"Use of radioactive isotopes in metallurgy." Reviewed by
L.A. Shvartsman, I.A. Tomilin.   Zhur.fiz.khim. 31 no.3:740-742
Mr '57.   (MIRA 10:7)
        (Radioisotopes--Industrial applications) (Metallurgy)

AUTHOR: Malkin, V.I., Khokhlov, S.F., Shvartsman, L.A. 76-11-16/35

TITLE: Determination of the Cation Transport Numbers in the Melt $Na_2O.K_2O.4SiO_2$ (Izmereniye chisel perenosa kationov v rasplave $Na_2O.K_2O.4SiO_2$)

ABSTRACT: The relative mobility of the cations Na^+ and K^+ with a charge, the radii of which differed noticeably from each other, was investigated in a silicate melt, the composition of which corresponds to the formula $Na_2O.K_2O.4SiO_2$. For the determination of the transmission numbers for Na^+ and K^+ the method [Ref.2] described already previously was applied by making use of the radio isotopes Na^{24} and K^{42}. The results of the experiments were somewhat surprising. They showed that the mobilities of the Na^+- and K^+-ions are nearly equal in the melt investigated here. There are 1 figure and 6 references, 3 of which are Slavic

Card 1/2

76-11-16/35

Determination of the Cation Transport Numbers in the Melt $Na_2O.K_2O.4SiO_2$

ASSOCIATION: Institute for Metallurgy and Metal Physics. Central Scientific Research Institute of Ferrous Metallurgy, Moscow (Institut metallovedeniya i fiziki metallov. Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii, Moskva)

SUBMITTED: July 14, 1956

AVAILABLE: Library of Congress

Card 2/2

20-2-38/67

AUTHOR   KOZHEVNIKOV I.Yu., SHVARTSMAN L.A.
TITLE   On the Thermodynamics of the Dephosphoration of Iron.
            (O termodinamike reaktsii deforsforatsii zheleza -Russian)

ABSTRACT   Many papers dealt with the phosphorus distribution in the system:
            metal-slag. On account of difficulties in the experiments,however,
            the exact values of thermodynamic functions of dephosphorization
            reactions of iron by slag of different composition are lacking.
            In the present paper a new investigation method of the distribu-
            tion equilibrium of phosphorus is applied. Its fundamental idea
            is an effective saturation of the metal with radioactive phospho-
            rus introduced into the slag at the very beginning at a constant
            temperature. This method makes it possible to compute the values
            both of the thermal effect and of the reaction entropy of the de-
            phosphorization for slag of a certain composition from the tempe-
            rature dependence of the exponent of the phosphorus distribution
            L_p. Assuming any molecular composition of molten slag the equi-
            librium constant of the reaction

            $$P + 5/2\ Fe^{++} + 4\ O^{--} \rightleftharpoons PO_4^{-3} + 5/2\ Fe \quad (1)$$

            can be described in a general form

            $$K_a = L_p \varphi\ (\textstyle\sum C_i)\ f\ (\textstyle\sum \gamma_i) \quad (2)$$ where $\varphi(\textstyle\sum C_i)$ denotes the relation
            of the equilibrium concentrations of the reaction participants with

Card 1/3

On the Thermodynamics of the Dephosphoration of Iron.   20-2-38/67

the exception of phosphorus, and $f(\sum \delta_i)$ denotes the relation of the activity coefficients of all reaction participants. The character of these functions is unknown. However, $\varphi(\sum c_i)$ does not depend on temperature. After further computations the authors obtain the value ΔH which denotes the sum of the reaction heat ΔH^0 between the pure substances and the heat of the mixtures $\sum \Delta H_{CM}$. ΔS^0 is the entropy modification at the transition of the phosphorus from a 1 per cent solution in iron into a 1 per cent solution in the slag. As the simplest standard system ferruginous slag was selected, in which cations in form of oxides: Ca^{++}, Sr^{++} and Ba^{++} were introduced, which differ considerably by the radius value. The results obtained about phosphorus distribution between iron and ferruginous slag are described by the equation

$$lg\ L_p = \frac{10900}{T} - 6,41,$$ from which the value ΔH is equal to

$5o.ooo$ kal/g-pressure gauge. In this case $K_a = AL_p \dfrac{\gamma_{PO_4}^{-3}}{\gamma_P}$, where A

-is the transition coefficient from weight percents to molar shares. From the temperature dependency K_a it can be obtained: $\Delta H^0 =$

$$= \Delta H + \Delta H_{CM}^{PO_4^3} - \Delta H^P_{CM}.$$ For slag of complicated compositions

H_{CM}^P remains invariable. The results of the investigation show that the entropic component of the free energy which depends on the charge magnitude and the mutual position of the ions in the fused mass of the slag has an important influence on the equilibrium of the dephosphorization reaction. This influence

Card 2/3

On the Thermodynamics of the Dephosphoration of Iron. 20-2-38/67
anionical.
(With 4 illustrationes, 2 citations from Slav publications).

ASSOCIATION   Institute for Metallography and Metallic Physics of the Central
               Scientific Research Institute for Iron-Metallurgy.
PRESENTED BY   KURDYUMOV G.V.
SUBMITTED   25.1o.1956
AVAILABLE   Library of Congress
Card 3/3

Shvartsman, L.A.

KURDYUMOV, G.V., otvetstvennyy red.; SAMARIN, A.M., red.; SHVARTSMAN, L.A., red.; MALKIN, V.I., red.; GOLIKOV, V.M., red.; RABEZOVA, V.A.; red.; CHERNOV, A.N., red.izd-va; SIMKINA, Ye.N., tekhn.red.; KASHINA, P.S., tekhn.red.

[Metallurgy and physical metallurgy proceedings of the Conference on the Use of Radioactive and Stable Isotopes and Radiation in the National Economy and in Science] Metallurgiia i metallovedenie; trudy Vsesoiuznoi nauchno-tekhnicheskoi konferentsii po primeneniiu radioaktivnykh i stabil'nykh izotopov i izluchenii v narodnom khoziaistve i nauke. Moskva, Izd-vo Akad. nauk SSSR, 1958. 518 p.
(MIRA 11:6)

1. Vsesoyuznaya nauchno-tekhnicheskaya konferentsiya po primeneniyu radioaktivnykh i stabil'nykh izotopov i izluchenii v narodnom khozyaystve i nauke. 1957.
(Metallurgy)   (Physical metallurgy)

SOV/1728

PHASE I BOOK EXPLORATION

Akademiya nauk SSSR. Institut metallurgii

Sovremennyye problemy metallurgii (Modern Problems in Metallurgy)
Moscow, Izd-vo AN SSSR, 1958. 840 p. 3,000 copies printed.

Resp. Ed.: A.A. Samarin, Corresponding Member, USSR Academy of
Sciences; Ed. of Publishing House: V.S. Kubarikov, and
A.V. Serov; Tech. Ed.: T.V. Polyakova.

PURPOSE: This book is intended for scientific and technical per-
sonnel in the field of metallurgy.

COVERAGE: This is a collection of articles on certain aspects of
Soviet metallurgy. The book is dedicated to Academician
Ivan Pavlovich Bardin on the occasion of his 75th birthday. The
book is divided into seven parts. The first part consists of
two articles presenting a brief account of the biography and
professional activity of the Soviet metallurgist. It includes an
article by John Chipman, Nicholas Grant, and John Elliott (M.I.T.,
USA) describing their meeting with Bardin in Moscow and also his
visit to the United States. The second part consists of three
articles and deals with raw materials and fuels for the Soviet
metallurgical industry. The third part represents the major
aspects of the book; it consists of 25 articles dealing with the
various basic problems of the metallurgy of pig iron and steel.
The fourth part consists of two articles treating the metal-
lurgy of nonferrous metals. The fifth part consists of three
articles on the forming of metals. The sixth part consists of
eight articles discussing certain aspects of physical metal-
lurgy. The last part deals with general problems in the field
of metallurgy. References are given after each article. No
personalities are mentioned.

TABLE OF CONTENTS:

SOV/137-58-8-16481

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 8, p 35 (USSR)

AUTHORS: Osipov, A.I., Shvartsman, L.A., Iudin, Ye. V., Sazonov, M.L.

TITLE: On the Uniform Distribution of Small Quantities of a Substance in the Slag During Smelting of Steel in a 350-t Furnace (O rav-nomernom raspredelenii maloy dobavki v shlake pri vyplavke stali v 350-t pechi)

PERIODICAL: V sb.: Staleplavil'n. proiz-vo. Moscow, Metallurgizdat, 1958, pp 218-224

ABSTRACT: In order to investigate the problem of the rate at which a substance distributes itself uniformly in a slag during open-hearth smelting, a radioactive isotope, Ca^{45}, encased in an ampoule, was introduced into the slag through the central open-ing of the furnace; slag samples were withdrawn through the other openings. The intensity of radioactivity was measured with a BFL-25 counter. The counting rate was determined by the thick-layer method, a procedure which eliminated the need for weighing operations. The accuracy of the radiometric measurements constituted 5% including statistical errors and errors caused by disturbances in geometric conditions of

Card 1/2

SOV/137-58-8-16481

On the Uniform Distribution of Small Quantities of a Substance (cont.)

measurement. The rate of distribution of a small quantity of an additive is smaller in slag than in metal; 30-35 minutes are required for leveling off of the tracer in the case of slag, and 8-15 minutes in the case of metal, despite the fact that the volume of slag is considerably smaller. Rates of turbulent diffusion of Ca in the slag amount to 50-100 cm^2/sec and are smaller by one order than the corresponding values of radioactive Co in steel; in this connection, the author comments on an analogous difference between the kinematic viscosity of steel and that of basic open-hearth slags. The distribution of radioactive Ca in the slag is strongly affect d by the aerodynamic pressure of the flame.

L.K.

1. Steel--Production   2. Slags--Properties   3. Metals--Distribution
4. Calcium isotopes (Radioactive)--Performance

Card 2/2

SHVARTSMAN, L.A., doktor khim.nauk; MALKIN, V.I., kand.tekhn.nauk; TOMILIN, I.A., kand.tekhn.nauk

A.N. Morozov's article "Modern slag theory and the theory of steel smelting processes." Izv. vys. ucheb. zav.; chern. met. no.7:63-65 Jl '58.   (MIRA 11:10)
            (Steel—Metallurgy)

SOV/24-58-10-17/34

AUTHORS: Kozhevnikov, I. Yu., Shvartsman, L. A. (Moscow)

TITLE: Thermodynamics of the Dephosphorization Reaction of Liquid Iron with Four-Component Open-Hearth Type Slags (Termodinamika reaktsii defosforatsii zhidkogo zheleza chetyrekh-komponentnymi shlakami martenovskogo tipa)
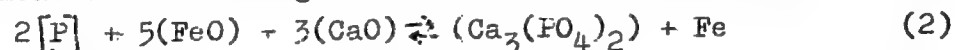
ABSTRACT: In many steel melting processes the dephosphorization reaction approaches equilibrium. Favourable conditions for the reaction are produced in the open-hearth when phosphoric iron is being treated by the scrap-ore process during melt down and the thermodynamics of the dephosphorization of iron by slags of the system $CaO - FeO - SiO_2 - P_2O_5$ are therefore of interest for improving melting conditions. The authors now describe an investigation which had the object of determining the influence of SiO_2 and P_2O_5 when present together in basic slags on the change in the thermodynamics functions of the phosphorus reaction. The successive saturation method previously described by the authors (Refs.5 and 6) was used, which enables the temperature dependence of the phosphorus partition coefficient for a slag of a given composition to

Card 1/3

Thermodynamics of the Dephosphorization Reaction of Liquid Iron with Four-Component Open-Hearth Type Slags

be determined. The distribution was found by using the radioactive phosphorus isotope P^{32}. Both synthetic and melting slags were investigated. Fig.1 shows the influence of temperature and duration of heating of the slag/metal system on the transfer of phosphorus and Fig.2 the dependence of the logarithm of the partition coefficient on the reciprocal of the temperature for the various slags investigated (compositions tabulated). The results of calculations of ΔH and ΔS^{o} are shown in Fig.3 as functions of the SiO_2 - percentage. The authors discuss the results and show (Fig.4) that the data of various investigators agree with the relation found by them for the entropy-change. They conclude that the heat content change associated with the reaction

$$2[P] + 5(FeO) + 3(CaO) \rightleftarrows (Ca_3(PO_4)_2) + Fe \qquad (2)$$

is independent of slag composition over a wide range of concentration; this indicates the existence of stable ionic

Card 2/3

SOV/24-58-10-17/34

Thermodynamics of the Dephosphorization Reaction of Liquid Iron with Four-Component Open-Hearth Type Slags

groupings which can be considered as silicophosphates. The partition of phosphorus between metal and slag for the system investigated is almost entirely determined by the entropy change of the phosphorus reaction, which depends on the slag composition; when slag and metal temperatures differ it is the latter that determines the phosphorus partition equilibrium. There are 5 figures, 1 table and 13 references, 7 of which are Soviet, 3 English and 3 German.

SUBMITTED: September 30, 1957.

Card 3/3

AUTHOR: Mortimer, L. A.   107/52-24-8-1/45

TITLE: Attempts to Study Iron Metallurgy With Radioactive Isotopes
            (Ob opyte primeneniya radioaktivnykh isotopov v chernoy me-
            tallurgii)

PERIODICAL: Zavodskaya Laboratoriya, 1958, Vol. 24, Nr 8, pp. 915-921 (USSR)

ABSTRACT: The experiments mentioned above were concerned with studying
            the production of molten steel, and were methodically divided
            into three main groups. The first group of experiments in-
            volved the use of radioactive isotopes as tracers. Investiga-
            tions concerned with non-metallic inclusions in steel were
            part of this group and were carried out in the Kuznetsk and
            Magnitogorsk metallurgic 1 Kombinat (Kuznetskiy   metal-
            lurgicheskiy kombinat), and in factories of
            Chelyabinsk, Stalino, "Elektrostal'", "Serspetek 1", and
            "   ",   1'   other institutions. Also
            included in this group were determinations of the impurities
            in steel b using sulfur. Determinations of this kind were
            carried out in the Beloretsk Metallurgic 1 Kombinat (Beloretskiy
            metallurgicheskiy kombinat), in the "Zaporozhstal'" factory,

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POV/?-22-1-1

Attempts to Study Iron Metallurgy with Radioactive Isotopes

...nd in the metallurgical factory i-lino **(Stalinskiy**   me-
...lurgicheskiy zavod). Studies on the kinetics of crystalli-
...tion of steel ingots were carried out at the "Azovstal"
factory. ... ... used in the investigation... on the
...mium process. With one method the activity of the
...sample was measured, and the time for the formation of
the liquid phase in the radioactively-tagged layer of the
slag formation was noted. The second method was that of iso-
tope dilution. The Moscow Institute for Steel (Moskovskiy
institut ... li) in conjunction with Sikyuzhrud successfully
began the working-out of the express-method for determining
th compound solid phases. Many interesting results o. ...
...tudy of the diffusion of elements in molten slag were ....
...   . the   ...cow Institute for Steel, the
... ...gt ... institute (Ural'skiy politekhnicheskiy
... titut), and the Institute for Metal Physics ... (ITCHM
Institut metallofiziki Y...TICh").

Card 7/2

30-1-13/39

AUTHOR: Shvartsman, L. A., Doctor of Chemical Sciences.

TITLE: The Practice of the Application of Isotopes for Technical Purposes (Iz praktiki primeneniya izotopov v tekhnike).

PERIODICAL: Vestnik AN SSSR, 1958, Vol. 28, Nr 1, pp. 79-83 (USSR)

ABSTRACT: The majority of reports delivered at the Paris Conference in 1957 dealt with problems of metallurgy. The Polish authors T. Mal'kevich and R. Vuzatovskiy used the radioactive isotopes Fe^{59} for the explanation of the distribution of non-metallic inclusions in a steel block, which get into the liquid metal during casting from the refractory materials. For this purpose iron oxide which was enriched by Fe^{59} was introduced into the raw clay from which the bricks for the lining of the casting device were made. After casting the ingots and blooms were auto-radiographed, and besides the radioactive intensity of radi-ation of the metal was measured. These experiments were also carried out with various refractories in order to determine their influence. The Soviet metal experts V. T. Borisov, V. M. Golikov, B. Ya. Lyubov, and G. V. Shcherbedinskiy in their re-port dealt with problems of diffusion in real metals, which have a polycrystalline structure. A. A. Zhukhovitskiy, M. Ye. Yanitskaya, and A. D. Botskov reported on the results of the

Card 1/3

The Practice of the Application of Isotopes for Technical
Purposes.

30-1-13/39

application of radioactive isotopes for the solution of cer-
tain problems of the diffusion theory. They developed a method
which makes it possible to measure the diffusion- and thermo-
dynamic characteristics of metallic mixed crystals simultan-
eously. The author described the methods of research by means
of radioactive isotopes of the equilibrium of the distribution
of elements between liquid iron and slags. O. S. Bogdanov and
his collaborators described the methods of the application of
radioactive isotopes for the investigation of processes of
flotation and ore enrichment. The flotoreagents were marked by
radioactive isotopes of sulphur. carbon, phosphorus, copper,
iron, zinc, and calcium. Great scientific and practical inter-
est was aroused by the problem of the solubility of slightly
volatile substances in steam under high pressure: a report on
this subject was delivered by M. A. Styrikovich. A. I. Veynik
spoke about the application of isotopes for the investigation
of heat- and mass transfer for the development of rational
methods of drying porous materials. The conference showed that
in the USSR and in other countries increased attention is be-
ing paid to the determination of new methods of using radio-
active isotopes, both in industry and in agriculture, and that

Card 2/3

The Practice of the Application of Isotopes for Technical   30-2-13,'39
Purposes.

> this is done not to the least extent because modern atomic in-
> dustry is able to supply enormous quantities of these substanc-
> es every day.

AVAILABLE: Library of Congress

1. Isotopes-Applications

Card 3/3

SOV/ 20-120-3-45/67

AUTHORS: Shvartsman, L. A., Osipov, A. I., Surov, V. F.,
Sazonov, M. L., Telesov, S. A., Ofengenden, A. M.

TITLE: On the Equilibrium of Sulfur Distribution Between Metal and
Slag in Open-Hearth Furnaces (O ravnovesii raspredeleniya
sery mezhdu metallom i shlakom v martenovskikh pechakh)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol. 120, Nr 3, pp.599-60⁴
(USSR)

ABSTRACT: In the analysis of the desulfurization process in such furnaces
a clearing up of the dependence of the equilibrium coeffi-
cient of the sulfur distribution on the slag composition
and on temperature is primarily necessary. If this is known,
that minimum limit-concentration of sulfur in the metal can
be estimated, which can be reached at optimum kinetic con-
ditions with the respective slag composition. The difference
between the actually observed and the equilibrium coeffi-
cient of the sulfur distribution is apparently conditioned
by the insufficient velocity of mass transfer in the system
slag-metal. From a thermodynamical point of view the basicity

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On the Equilibrium of Sulfur Distribution Between Metal and Slag in Open-
-Hearth Furnaces

of the slag is decisive for the desulfurization. Contrary to
current opinion an increase of the concentration of ferrous
oxide does not essentially impair the thermodynamical con-
ditions of steel desulfurization in slags of the Siemens-
-Martin type. At the same time an increase of the said con-
centration leads to a reduction of the viscosity of the
slag and accelerates the processes of mass transfer in it.
Fig 1 shows the values of the sulfur distribution coeffi-
cients in dependence upon Δ (difference between the mole-
-number of the basic and the acidous oxides contained in
100 g of slag = a measure of the basicity of the slag ac-
cording to Grant and Chipman, Ref 1). From this the follow-
ing fundamental conclusions can be drawn: 1) During the
melting period the sulfur content in the slag exceeds the
value corresponding to the equilibrium with the metal.
This circumstance is caused by the transition of the sulfur
from the furnace atmosphere into the slag. The transition of
the sulfur from the slag to the metal proceeds slowly, its
content, in the metal, however, rises (Fig 1). Moreover, the

Card 2/4   sulfur transition to the metal is chemically conditioned by

SOV/20-120-3-45/67

On the Equilibrium of Sulfur Distribution Between Metal and Slag in Open-
-Hearth Furnaces

the composition of the just formed slag. Then the slag is
acidous. The Δ-values are negative (Fig 1) and the values
of the equilibrium coefficients are very small. Figure 1
shows that during the melting period the desulfurization
tends towards equilibrium along two ways: a) By the passage
of sulfur from the slag to the metal and b) By the continuous
change in the amount of slag and its composition. An increase
in the amount of slag reduces the sulfur concentration,
whereas an increase of the basicity increases the equilibrium
coefficient of the distribution. In order to guarantee a com-
bination of thermodynamic and kinetic conditions favorable
to a successful desulfurization, such a slag regime must be
maintained, in which a) The silicon content in the slag is
kept low if possible during the entire melting process, and
b) The slag is kept in a sufficiently liquid state. This is
achieved by the introduction of liquefying additions, such
as agents containing ferrous oxide. There are 2 figures
and 2 references, 1 of which is Soviet.

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SOV/20-120-3-45/67

On the Equilibrium of Sulfur Distribution Between Metal and Slag in Open--Hearth Furnaces

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy
metallurgii
(Central Scientific Research Institute of Ferrous Metallurgy)
Stalinskiy metallurgicheskiy zavod
(Stalino Metallurgical Plant)

PRESENTED: January 9, 1958, by G. V. Kurdyumov, Member, Academy of
Sciences, USSR

SUBMITTED: January 9, 1958

1. Open hearth furnaces--Performance   2. Sulfur--Determination
3. Steel--Quality control   4. Slags--Properties

Card 4/4

SOV/20-121-6-19/45

18(3)
AUTHORS: Petrova, Ye. F., Lapshina, M. I., Shvartsman, L. A.

TITLE: The Solubility of Carbon in Alpha-Iron (Rastvorimost' ugleroda v al'fa-zheleze)

ABSTRACT: The authors developed a thermodynamical method for the immediate determination of the concentration of carbon in the solid solution. By combination with other data, the solubility of carbon in ferrite (in the equilibrium with cementite at low temperatures and also in equilibrium with γ-iron at higher temperatures) was calculated. The method investigated in this paper is characterized by the fact that the content of carbon in the iron may be determined without a chemical analysis. The carrying out of the measurements and the measuring apparatus are discussed in short. These experiments gave a linear dependence of

$r = P_{CO}^2/P_{CO_2}$ on $[\% \; C]_\alpha$. P_{CO} and P_{CO_2} denote the partial pressures of CO and CO_2 in the equilibrium and $[\% \; C]$ denotes

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the content of carbon in iron (percent   by weight). There-
fore the equilibrium constant $K_\alpha = p^2_{CO}/p_{CO_2} \left[\% C\right]_\alpha$ does not

depend on the concentration of carbon. K_α was measured in

the temperature interval 700 - 890°. In a diagram (Fig 2),
the results of these measurements are given in the coordinates
$lg\ K_\alpha$ and $(1/T)$. The experimental points agree well with a
straight line which satisfies the equation $lg\ K_\alpha = -(3240/T) + 5,13$. Therefore, the reaction $C + CO_2 \rightleftarrows 2CO$ has a negative

Joule effect, the value of which amounts to 14820 cal/mol.
The above-discussed results may be used for the determination
of the boundaries of the α-phase in the iron-carbon system.
First, the manner of determining the solubility of carbon
below entectoid temperature is discussed. After some steps,
the following expression is found for the solubility of
carbon in α-iron: $lg\ \left[\% C\right]^H_\alpha = -(4509/T) - 2,25 \cdot 10^{-4}\ T + 3,22.$

The results of the calculations carried out by means of these
equations are given in a table. According to these results,
the solubility of carbon in α-iron at the eutectoid tempera-
ture is very similar to 0,030 weight %. 2 other diagrams show

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The Solubility of Carbon in Alpha-Iron   SOV/2o-121-6-19/45

the data concerning the solubility of carbon, found by measur-
ing internal friction. Also these results agree satisfactori-
ly with the generally accepted values. The results obtained
with respect to the solubility of carbon seem to be more re-
liable than those found by the method of internal friction.
The results of this investigation may be used for the calcula-
tion of the concentrations of carbon in α-iron in equilibrium
with austenite at temperatures above eutectoid temperature.
There are 3 figures, 1 table, and 8 references, 1 of which
is Soviet.

ASSCOIATION: Institut metallovedeniya i fiziki metallov Tsentral'nogo
nauchno-issledovatel'skogo instituta chernoy metallurgii
(Institute of Metallography and Physics of Metals of the
Central Scientific Research Institute of **Ferrous Metallurgy**)

PRESENTED: April 24, 1958, by C. V. Kurdyumov, Academician
SUBMITTED: April 21, 1958

Card 3/3

SHVARTSMAN, L. A.

Л.А.Шварцман

НЕКОТОРЫЕ ВОПРОСЫ ТЕРМОДИНАМИКИ
ЖЕЛЕЗОУГЛЕРОДИСТЫХ РАСПЛАВОВ

SHVARTSMAN, L.A.

SAZONOV, N.I.; SHVARTSMAN, L.A.

Distribution of elements of the 5th group of the periodic
table between iron - iron based slags.

report submitted for the 5th Physical Chemical Conference on
Steel Production.

MOSCOW _   30 JUN 1958

SHVARTSMAN, L. A.

18(0)

PHASE I BOOK EXPLOITATION   SOV/2125

Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii. Institut Metallovedeniya i fiziki metallov

Problemy metallovedeniya i fiziki metallov (Problems in Physical Metallurgy and Metallophysics) Moscow, Metallurgizdat, 1959. 590 p. (Series: Its: Sbornik trudov, 6) Errata slip inserted. 3,660 copies printed.

Additional Sponsoring Agency: USSR. Gosudarstvennaya planovaya komissiya.

Ed. of Publishing House: Ye.N. Berlin; Tech. Ed.: P.G. Islent'yeva. Editorial Board: D.S. Kamenetskaya, B.Ya. Lyubov (Resp. Ed.), Ye.Z. Spektor, L.M. Utevskiy, L.A. Shvartsman, and V.I. Malkin.

PURPOSE: This book is intended for metallurgists, metallurgical engineers, and specialists in the physics of metals.

COVERAGE: The papers in this collection present the results of investigations conducted between 1954 and 1956. Subjects

Card 1/8

covered include crystallization of metals, physical methods of influencing the process of crystallization, problems in the physical chemistry of metallurgical processes, development of new methods and equipment for investigating metals, and production control. References follow each article, and

TABLE OF CONTENTS:

PART I. CRYSTALLIZATION OF METALS

The distribution process was studied with the use of a radioactive isotope (Ca45). It was shown that the process of diffusion of a substance in slag takes place at a considerably slower rate than in metal.

A method for determining the speed of melting scrap in an open-hearth furnace in the scrap-ore process was developed on the basis of this investigation. The method is based on "isotopic dilution" using radioactive cobalt. It was shown that the melting speed depends on the duration of the pig iron pouring process and carbon content in the bath.

The transfer of sulfur from the gas phase to the bath takes place most intensively during the loading of the metallic portion of the charge. The speed of sulfur absorption during this period is 17-25 percent per hour, during preheating 8-11 percent, and during final melting 3-7.5 percent.

It is shown that the activity of Carbon in Gamma Iron with additions of Mn, Cr, V, and Ti is considerably higher than in non-alloyed austenite. This would indicate that the bond strength of carbon dissolved in Gamma Iron is substantially increased by the introduction of carbide forming elements.

PHASE I   BOOK EXPLOITATION

SOV/2117

24(8)

Soveshchaniye po eksperimental'noy tekhnike i metodam vysokotempera-
turnykh issledovaniy, 1956

Eksperimental'naya tekhnika i metody issledovaniy pri vysokikh tem-
peraturakh; trudy soveshchaniya (Experimental Techniques and
Methods of Investigation at High Temperatures; Transactions of the
Conference on Experimental Techniques and Methods of Investigation
at High Temperatures) Moscow, AN SSSR, 1959. 789 p. (Series:
Akademiya nauk SSSR. Institut metallurgii. Komissiya po fiziko-
khimicheskim osnovam proizvodstva stali) 2,200 copies printed.

Resp. Ed.: A.M. Samarin, Corresponding Member, USSR Academy of
Sciences; Ed. of Publishing House: A.L. Bakhviter.

PURPOSE: This book is intended for metallurgists and metallurgical
engineers.

COVERAGE: This collection of scientific papers is divided into six
parts: 1) thermodynamic activity and kinetics of high-temperature
processes 2) constitution diagram studies 3) physical properties
of liquid metals and slags 4) new analytical methods and pro-
duction of pure metals 5) pyrometry, and 6) general questions.
For more specific coverage, see Table of Contents.

TABLE OF CONTENTS:

I. DETERMINATION OF THERMODYNAMIC ACTIVITY AND METHODS OF INVESTIGATING THE KINETICS OF HIGH-TEMPERATURE PROCESSES

SOV/2117

Experimental Techniques and Methods (Cont.)

SOV, 180-59-1-5/29

AUTHORS: Mogutnov, B.M., Perevalov, N.N. and Shvartsman, L.A.
             (Moscow)

TITLE: Influence of Calcium Oxide on the Distribution of Tungsten
             between Liquid Iron and Slag (Vliyaniye okisi kal'tsiya
             na raspredeleniye vol'frama mezhdu zhidkim zhelezom i
             shlakom)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Otdeleniye tekhnicheskikh
             nauk, Metallurgiya i toplivo, 1959, Nr 1, pp 22-28 (USSR)

ABSTRACT: The object of the work described was to study the
             behaviour of tungsten in oxide melts at high temperatures,
             especially to obtain accurate data on the distribution of
             the element between iron and slag in relation to thermo-
             dynamic conditions. A successive saturation method,
             described by Shvartsman and others (Refs 1-3) was used.
             In this small portions of a previously prepared slag
             containing a radioactive isotope of the element concerned
             are added to the iron at a constant temperature until
             further addition produces no further increase in the
             radioactivity of the iron. The distribution coefficient
             is calculated from the radioactivities of metal and slag.
             The isotope (W^{185}) was added to the melted slag in an
Card 1/3   induction-heated iron crucible in the proportion of

SOV/180-59-1-5/29

Influence of Calcium Oxide on the Distribution of Tungsten between
Liquid Iron and Slag

50 mg (activity 1 millicurie) per 400 g of slag, which was
kept molten long enough to allow complete oxidation and
mixing. About 50 g of iron (electrolytic) were used,
metal temperature being measured with a micro-optical
pyrometer and kept constant. Fig 3 shows the count for
metal samples at temperatures of 1600, 1640 and 1700°C.
Results were reproducible even when equilibrium was
approached from different directions (ie with excess or
with deficiency of tungsten in the iron). The heat-content
and entropy changes associated with the transfer of 1 g
atom of tungsten from iron into slag were calculated from
the distribution coefficient values at different tempera-
tures (Fig 4 shows the linear relations between the
logarithms of the coefficient and 10^4/(absolute tempera-
ture)). With a slag consisting exclusively of iron
oxides the heat-content and entropy changes were 14800 cal
and 3.84 cal/degree g-atom, respectively. With lime-
containing slags the heat-content change is greater,
reaching (Fig 5) a value of 41000 cal for a slag with a
molar fraction of CaO of 0.40 (all slag iron assumed to be

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SOV/180-59-1-5/29

Influence of Calcium Oxide on the Distribution of Tungsten between Liquid Iron and Slag

in the form of FeO). The authors discuss their own and published results (Refs 5 and 6) and estimate the heat of mixing of WO_3 with ferruginous limey slag. They conclude that this oxide has a pronounced acidic nature, and that with increasing basicity of open-hearth slags the oxidation of tungsten from liquid steel should increase.

Card 3/3 There are 6 figures, 2 tables and 7 references, 3 of which are Soviet, 3 English and 1 German.

SUBMITTED: March 1, 1958

SOV/180-59-2-2/34

AUTHORS: Travin,O.V. and Shvartsman,L.A. (Moscow)

TITLE: Dephosphorization of Pig Iron with Solid Mixtures
(Defosforatsiya chuguna tverdymi smesyami)

PERIODICAL: Izvestiya Akademii Nauk, SSSR, Otdeleniye Tekhnicheskikh
Nauk, Metallurgiya i Toplivo, 1959, Nr 2, pp 8-12 (USSR)

ABSTRACT: The authors state that, unlike desulphurization, the
external dephosphorization of pig iron has received little
research attention and is not applied in practice.   A
difficulty of such a process is that the phosphorus has
to be oxidized while preserving a high concentration of
carbon, (silicon, which gives rise to additional difficul-
ties, has to be oxidized before dephosphorization). The
object of the work described was to see whether solid
lime-ferric oxide mixtures could be used for such
dephosphorization. The mixtures with various lime : oxide
ratios were made in tablets weighing 200 - 2500 mg, which
were placed on the surface of molten iron containing
radioactive phosphorus P^{32}. The initial phosphorus
content of the iron was 0.005 - 0.737%. Temperatures
(1200 - 1600 ⁰C) were measured with an optical pyrometer.
From measurement of the radioactivities of the top and

Card 1/3

Dephosphorization of Pig Iron with Solid Mixtures

bottom faces of the tablet the thickness of the phosphorus-containing layer (defined as the thickness over which the phosphorus concentration changes ten-fold) was determined. The authors admit the inaccuracies of this procedure. Loss in weight of the tablets always took place, due to reduction of their iron oxide. It was found (Table 1) that both loss in weight and quantity of phosphorus transferred to the tablet were approximately proportional to the tablet/metal contact area. The tablets were 50% CaO, 50% Fe_2O_3, the temperature 1265°C and initial phosphorus-content 0.017%. The influence of temperature was studied using 65% CaO, 35% Fe_2O_3 in tablets weighing 2000 mg with iron (0.02% P) weights of 500 g. The results (Table 2) indicated the advantage of low temperatures. Further tests at about 1235°C showed that there is an optimal contact time. The authors discuss the kinetics of the process, and the influence of the effective diffusion coefficient of the phosphorus. Special experiments at 1200-1300 °C showed that this does not exceed 10^{-7} cm^2/sec, indicating that a layer of phosphates containing over 20% phosphorus is formed on the surface of the slag particles

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SOV/180-59-2-2/34

Dephosphorization of Pig Iron with Solid Mixtures

for the whole iron phosphorus-content range studied. The authors have also calculated from their experimental results for 27.2% lime tablets the mean P_2O_5 content in the phosphorus-containing layer, the weight of the layer and the quantity of phosphorus in the tablets, (Table 4). The general conclusion is that $CaO-Fe_2O_3$ solid slags can be used for dephosphorizing silicon-free iron. There are 4 tables and 2 English references.

SUBMITTED: July 2, 1958

Card 3/3

SOV/180-59-3-7/43

AUTHORS: Sazonov, M.L. and Shvartsman, L.A. (Moscow)

TITLE: Distribution of Niobium Between Iron and Ferruginous Slag

PERIODICAL: Izvestiya Akademii nauk SSSR, Otdeleniye tekhnicheskikh nauk, Metallurgiya i toplivo, 1959, Nr 3, pp 34-36 (USSR)

ABSTRACT: The authors describe their investigation of the behaviour of niobium in iron/ferruginous slag. Radioactive Nb^{95} was used to determine the niobium-content of iron after it had been kept in contact with the slag. Flakes of electrolytic iron were moistened with Nb^{95}-containing aqueous $Nb_2(C_2O_4)_5$ and melted in a neutral atmosphere. The logarithm of the distribution coefficient was found, for the temperature range 1535 to 1740°C, to be equal to $(70500/4.575T)-3.18$ where T is the absolute temperature. The linearity of the relation is shown graphically, the heat-content change associated with the transfer of 1 g atom of niobium from metal to slag being 70500 cal. Good agreement for this with the calculated value (72.250 cal/g atom) confirms that in   slag niobium is in the form Nb_2O_5 and indicates that both in slag and metal the heats of mixing are low. From their own and published (Ref 4)

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SOV/180-59-3-7/43

Distribution of Niobium Between Iron and Ferruginous Slag

data the authors calculate the value of the equilibrium constant for the reaction $2Nb(\text{in Fe}) + 5(FeO) = (Nb_2O_5) + 5Fe$ at $1873°K$ to be 3.6×10^{13}. There is 1 figure and 4 references, 3 of which are Soviet and 1 English.

SUBMITTED: February 25, 1959

Card 2/2

TOMILIN, I.A., kand.tekhn.nauk; SHVARTSMAN, L.A., doktor khim.nauk

Effect of silica, calcium oxide and sodium oxide on the distri-
bution of sulfur and phosphorus between iron and iron slag.
Probl.metalloved.i fiz.met.   no.6:199-220 '59. (MIRA 12:8)
    (Iron--Metallurgy) (Slag) (Thermochemistry)

KOZHEVNIKOV, I.Yu., kand.tekhn.nauk; SHVARTSMAN, L.A., doktor khim.nauk

Effect of alkaline earths on the equilibrium of the iron de-
phosphorization reaction. Probl.metalloved.i fiz.met. no.6:221-258
'59.   (MIRA 12:8)
    (Iron--Metallurgy) (Alkaline earths) (Thermochemistry)

S/137/62/000/005/005/150
A006/A101

AUTHORS: Petrova, Ye. F., Shvartsman, L. A.

TITLE: The effect of alloying elements upon the thermodynamic activity of carbon in gamma-iron

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 5, 1962, 9, abstract 5A58 ("Sb. tr. In-t metalloved. i fiz. metallov Tsentr. n.-i. in-ta chernoy metallurgii", 1959, v. 6, 259-292)

TEXT: To determine the C content in γ-Fe directly during the experiment without removing the specimen from the unit, the circulation method was employed that had been developed by M. I. Temkin and his collaborators ("Zh. fiz. khimii", 1949, v. 23, 695). The equilibrium of the reaction C (dissolved in Fe) + CO_2 = $2CO$. was attained as a result of pure CO circulation in a closed, preliminarily evacuated circuit, into which a carbonfree Fe sample was placed at constant controlled temperature. After the equilibrium had been attained, CO_2 was frozen out, CO was evacuated and partial CO_2 pressure was determined by measurement with the Mac-Leod manometer. The weight of C dissolved in the Fe-specimen was determined from the amount of CO_2. Greater CO pressures were measured with the

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.5(2,4)
AUTHORS: Perevalov, N. N., Mogutnov, B. M.,   SOV/20-124-1-42/69
             Shvartsman, L. A.

TITLE: The Effect of the Basicity of Slag on the Oxidation of Chromium
             Subgroup Elements Dissolved in Liquid Iron (Vliyaniye
             osnovnosti shlaka na okisleniye elementov podgruppy khroma,
             rastvorennykh v zhidkom zheleze)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 1, pp 150-152
             (USSR)

ABSTRACT: The oxidation of the elements dissolved in iron is to a
             considerable extent due to the interconnection between the
             acid - basic properties of the forming oxides and the basicity
             of slag. Slags containing only iron oxides (iron containing
             slags) were regarded as neutral by the authors. They were
             regarded as the basis to which calcium oxide and silica, the
             most typical oxides occurring in slags with respect to their
             acid - basic properties, were added. The authors investigated
             the dependence of the distribution coefficient L of the
             corresponding element at low concentration between iron and slag
             in dependence on the composition of slag. L was determined

Card 1/4

The Effect of the Basicity of Slag on the   SOV/20-124-1-42/69
Oxidation of Chromium Subgroup Elements Dissolved in Liquid Iron

according to the method applied in reference 1 with the help
of radioactive isotopes Cr^{51}, Mo^{99} and W^{185}. The results
obtained show that in all cases the dependence of L on
temperature is satisfactorily expressed by the equation

$$\lg L = \frac{A}{T} + B \quad (1).$$ A denotes the heat effect of the reaction

$(A = - \cdot \frac{\Delta H}{4.575})$, and the constant B denotes the

variation of entropy. The composition of the investigated slags
is given in table 1. L as well as A and B depend but very
little on the concentration of the calcium oxide in the case of
chromium oxidation. The presence of SiO_2 in the iron containing

slag means an increase of the heat of reaction of chromium
oxidation. Cr_2O_3 is a basic oxide (Ref 3). The authors state

that this oxide in the slag melts is to be regarded as a weak
base. It can be seen (Table 1) that in the case of the
introduction of calcium oxide into the slag L is doubled and
trebled compared to the iron containing slag. Also the heat
effect of the reaction increases. The introduction of silica

Card 2/4

The Effect of the Basicity of Slag on the   SOV/20-124-1-42/69
Oxidation of Chromium Subgroup Elements Dissolved in Liquid Iron

has a contrary effect; the heat effect remains almost
unchanged. This fact makes the conclusion possible that the
decrease of L is caused by the entropy component of free energy.
The main difference between molybdenum oxidation and chromium
is therefore the fact that in the latter case a higher oxide is
formed which clearly behaves like an acid in the slag. In the
case of tungsten oxidation CaO has a rather increasing effect
upon L and the heat of reaction (Ref 4). They are both reduced
by SiO_2. Thus, the balance of the oxidation reaction of

molybdenum and tungsten which form in the slag higher oxides
with marked acid properties - depends considerably upon
basicity. With respect to chromium this is the case only to a
negligible extent. There are 1 table and 4 references, 3 of
which are Soviet.

Card 3/4

The Effect of the Basicity of Slag on the   SOV/20-124-1-42/69
Oxidation of Chromium Subgroup Elements Dissolved in Liquid Iron

ASSOCIATION: Institut metallovedeniya i fiziki metallov Tsentral'nogo
             nauchno-issledovatel'skogo instituta chernoy metallurgii
             (Institute of Metallography and Metal Physics of the Central
             Scientific Research Institute of Ferrous Metallurgy)

PRESENTED: August 15, 1958, by G. V. Kurdyumov, Academician

SUBMITTED: August 13, 1958   .

Card 4/4

80196

S/129/60/000/04/004/020

E073/E535

18.7500

AUTHORS: Petrova, Ye. F., Candidate of Technical Sciences,
Lapshina, M. I., Candidate of Chemical Sciences and
Shvartsman, L. A., Doctor of Chemical Sciences

TITLE: Influence of Alloying Elements on the Thermodynamic
Activity and the Solubility of Carbon in α-iron

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov,
1960, No 4, pp 22-25 (USSR)

ABSTRACT: Up to now the solubility of carbon in alloyed ferrite
has not been determined by thermodynamic methods. In
this paper the results are given of the study of the
influence of certain alloying elements on the thermo-
dynamic activity and the solubility of carbon in α-iron.
These magnitudes were determined on the basis of
equilibrium data measured on mixtures of $CO-CO_2$ with
carbon, which were in the solid solution, using a
circulation method described in earlier work of the
authors (Ref 1). For comparison a solution of carbon
in α-iron was chosen which did not contain other

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S/129/60/000/04/004/020
E073/E535

Influence of Alloying Elements on the Thermodynamic Activity and
the Solubility of Carbon in α-iron

admixtures. In this case the equilibrium constant of
the reaction $C + CO_2 = 2CO$ does not depend on the
carbon concentration in the metal. Equations are
derived governing the solubility of carbon in alloys
of α-iron with cobalt, Eqs (12)-(14).   By means of
these equations, the solubility values were calculated
for three alloys with various cobalt contents as a
function of the temperature and these are plotted in
Fig 1; for comparison the solubility curve for pure
ferrite is also plotted in this figure. The presence
of manganese in α-iron reduces the activity of the
carbon and consequently the solubility should increase.
Assuming that the iron carbide, which is rejected in the
studied alloys, does not contain manganese, the
solubility of carbon in these alloys can be calculated
in the same way as was done for the Fe-Co system; the
resulting equations are Eqs (18) and (19). It can be

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S/129/60/000/04/004/020
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Influence of Alloying Elements on the Thermodynamic Activity and
the Solubility of Carbon in α-iron

seen that the addition of manganese to the α-iron
increases its solubility of carbon. Results calculated
on the basis of Eq (18) are graphed in Fig 2 (variation
of the solubility of carbon in Fe-Mn alloys as a function
of the temperature for various manganese contents).
The influence of silicon and chromium on the behaviour
of carbon in α-iron was investigated by determining the
respective activity coefficients. The results obtained
by the authors indicate that cobalt increases the
activity of carbon in the α-iron and this is also the
case for silicon. However, carbide forming elements of
the transition group Mn and Cr, which interact with
iron only slightly, bring about a reduction in the
activity of carbon in the α-iron. In earlier work (Ref 1)
the same qualitative results were obtained on the
influence of carbide forming elements on the activity
Card 3/4 of carbon in γ-iron.

80196

S/129/60/000/04/004/020
E073/E535

Influence of Alloying Elements on the Thermodynamic Activity and
the Solubility of Carbon in α-iron

There are 3 figures and 2 references, 1 of which is
Soviet and 1 English.

ASSOCIATIONS: Tsentral'nyy nauchno-issledovatel'skiy institut
chernoy metallurgii (Central Scientific Research Institute
for Ferrous Metallurgy) and Vsesoyuznyy zaochnyy
mashinostroitel'nyy institut (All Union Correspondence
Mechanical Engineering Institute)

Card 4/4

SAVOST'YANOVA, N.A.;   SHVARTSMAN, L.A.

Solubility of vanadium carbide in gamma iron. Fiz. met. i metalloved.
9 no. 4:515-519 Ap '60.   (MIRA 14:5)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo
nauchno-issledovatel'skogo instituta chernoy metallurgii.
          (Vanadium carbide)   (Solutions, Solid)

12.8400

~~18 (7), 21 (0)~~

S/032/60/026/01/023/052
68212
BO1O/BC01

AUTHORS: Sazonov, M. L., Shvartsman, L.A.

TITLE: The Use of Radioactive Isotopes of Arsenic and Niobium for the investigation of Metallurgical Reactions

ABSTRACT: The authors describe methods which may be used for the investigation of the distribution of niobium and arsenic between an iron melt and the slag. Nb^{95} and As^{76} were used for the experiments; special attention was paid to their separation from radioactive impurities. 3 g portions of slag powder, saturated with $Nb_2^{95}(C_2O_4)_5$ and dried, were applied to the surface of the molten iron sample in order to investigate the powder by the method of successive saturation. It was found that the radioactive impurities (Ru^{106}) of Nb, but not Nb itself, pass over into the iron melt. Thus, a method can be worked out for the purification of Nb^{95} from radioactive impurities (Table: Radioactivity of Metal Samples in Equilibrium). Experiments in

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68212

The Use of Radioactive Isotopes of Arsenic and
Niobium for the Investigation of Metallurgical
Reactions

S/032/60/026/01/023/052
BO1O/BCO1

the temperature interval 1535 - 1740° showed that the tempera-
ture function of the distribution coefficient L_{Nb} obeys an

equation according to which 70,500 cal are liberated on oxida-
tion of 1 g-atom Nb (dissolved in iron). Since the distribution
coefficient L_{As} for arsenic is small, the method of sample

withdrawal was applied to investigate the equilibrium of
arsenic. Special experiments on the effect of radioactive im-
purities on the determination accuracy of L_{As} were carried out.

The slag was separated from the molten iron containing As^{76} by
"freezing on" to a steel rod. The procedure was frequently re-
peated and it was found that the radioactive impurities have a
greater distribution coefficient than arsenic and thus were
successively removed by repeated slag withdrawal (Fig 2). Thus,

As^{76} has to be freed from radioactive impurities before in-
vestigations of the As distribution between iron and slag are
carried out. It was found that L_{As} does not depend on the

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68212

The Use of Radioactive Isotopes of Arsenic and   S/032/60/026/01/023/053
Niobium for the Investigation of Metallurgical   B010/B004
Reactions

arsenic concentration in iron and thus it exists in the slag
as cation As^{3+} and not as As_2O_3 molecule. Due to the low value
of L_{As}, arsenic cannot be removed from the molten iron with
the slag. There are 2 figures, 1 table, and 4 Soviet references.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy
metallurgii (Central Scientific Research Institute of Iron
Metallurgy)

Card 3/3

84702

15.2142

S/020/60/133/006/005/016
B016/B060

AUTHORS: Alekseyev, V. I., Shvartsman, L. A.

TITLE: The Equilibrium in the System V_2C — H_2 — CH_4 — V

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 133, No. 6,
              pp. 1331-1333

TEXT: The authors determined the free formation energy of a vanadium
carbide with a composition similar to that of V_2C, which was in
equilibrium with metallic vanadium. Its structure was examined by X-ray
structural analysis. The authors studied the equilibrium
$V_2C_{(solid)} + 2H_{2(gas)} = CH_{4(gas)} + V_{(solid)}$ (2). The equilibrium constant
of reaction (2) was determined with the aid of an apparatus illustrated
in Fig. 1. The carbide powder investigated was introduced into a quartz
tube placed in a furnace. The furnace temperature was adjustable.
Hydrogen was allowed to circulate over the powder, and subsequently,
an H_2 — CH_4 mixture according to the progressing reaction (2). After

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S/020/60/133/006/005/016
B016/B060

The Equilibrium in the System
V_2C — H_2 — CH_4 — V

having obtained equilibrium, the authors burned the hydrogen in tube 2 which contained a copper oxide heated up to 300°C. The steam was frozen out in a liquid-nitrogen trap. For kinetic reasons, methane is not burned over copper oxide at 300°C (Refs. 3,4). The methane pressure was measured by means of a McLeod gauge. Since the reaction equilibrium is markedly shifted toward the left, the partial pressures of methane were very low (10^{-3} - 10^{-2} torr). In their calculation of K_r the authors equated the equilibrium pressure of hydrogen (about 190 - 300 torr) to the total pressure in the circulation apparatus. The total pressure was measured with a U-gauge (10) and by a microscopic determination of the level. Fig. 2 shows an X-ray picture of the sample investigated. Two phases are visible on it: metallic vanadium and a carbide with a hexagonal structure. According to Ref. 1, this carbide corresponds to V_2C as to its composition. The experiments were made between 600° and 1000°C. The equilibrium of reaction (1) was attained between 75 and 20 h depending on the temperature. The experimental results are represented in Fig. 3 as log K_r = f(1/T). The equation of the straight line reads: log K_r = 2201.9/T - 5.823 (3), and that of the free energy is:

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84702

The Equilibrium in the System
V_2C — H_2 — CH_4 — V

$\Delta G^{o}_{973-1273^{o}K} = -10,050 + 26.65$ T (4). A combination of reaction (2) with that for the methane formation (5) yields: $2V_{(solid)} + C_{(solid)} = V_2C_{(solid)}$ (7) and $\Delta G^{o}_{973-1273^{o}K} = -11,500 - 0.49$ T. The formation heat determined for vanadium carbide is a little lower than the one assumed for VC by an estimation in Ref. 2. This divergence is probably to be explained by the inaccurate determination of ΔH for VC. In vanadium-alloyed steels the excess carbide phase approaches the VC composition. The authors finally mention the applications of the above-derived equation. There are 3 figures and 6 references: 3 Soviet, and 2 German.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii (Central Scientific Research Institute of Ferrous Metallurgy)

PRESENTED: March 25, 1960, by G. V. Kurdyumov, Academician

Card 3/4

84702

The Equilibrium in the System
V_2C — H_2 — CH_4 — V

S/020/60/133/006/005/016
B016/B060

SUBMITTED: March 25, 1960

Card 4/4

S/137/62/000/005/009/150
A006/A101

AUTHORS: Sazonov, M. L., Shvartsman, L. A.

TITLE: Distribution of elements of the fifth group of a periodic system between iron and ferrous slag

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 5, 1962, 14-15, abstract 5A83 (V sb. "Fiz.-khim. osnovy proiz-va stali", Moscow, AN SSSR, 1961, 68-76)

TEXT: The method of radioactive isotopes was used to study the distribution of Sb, As and Nb between Fe and Fe-slag. Sb^{124}, As^{76} and Nb^{95} were used. Distribution of Sb and As was studied by taking off samples. Coefficient of distribution L was determined from the frequency recordings of slag and Fe batches. The experiments were carried out at $1,540 - 1,750^{\circ}C$. The temperature was measured with a microoptical pyrometer. To reveal the dependence of L on the concentration of the dissolved substance, experiments were made at $1,600^{\circ}C$ and variable content of Sb and As. The distribution of Nb was studied by the method of consecutive saturation (RZhMet, 1957, no. 5, 7519) $\lg L_{Sb} = 16,200/$ $4.575 T + 2.80/4.575$ (for $1,540 - 1,750^{\circ}C$ temperatures); $\lg L_{As} = - 26,500/$

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Distribution of elements of the fifth group ...

S/137/62/000/005/009/150
A006/A101

4.575 T $+$ $4.80/4.575$; $\lg L_{Nb} = 70,500/4.575$ T $- 14.55/4.575$ (for $1,535 - 1,740^\circ$C). At $1,600^\circ$C $L_{As} \approx 0.01$ and $L_{Sb} \approx 0.05$ and do not depend on As and Sb concentration in Fe. It is assumed that As and Sb are present in liquid Fe in the form of ions. The value of L_{Nb} is considerably higher (about 10^4). From the temperature dependence of L the authors calculated oxidation heats of elements in liquid Fe and changes of entropy. It is shown that Sb and As oxidation are accompanied by heat absorption (16,200 and 26,500 cal/g-atom respectively) and increased entropy (2.8 and 4.8 cal/degree-g-atom respectively) Nb oxidation is accompanied by heat liberation and decreased entropy (70,500 cal/g-atom and 14.55 cal/degree.g-atom respectively). A comparison of the results obtained with literature data made it possible to assert that Sb and As are present in Fe in trivalent state, and Nb in pentavalent state. Low L_{Sb} and L_{As} values are connected with the fact that Sb and As are forming, during oxidation, low stable trioxides with weakly marked acid-basic properties.

A. Panov

[Abstracter's note: Complete translation]

Card 2/2

ZUROV, V.F.; TRAVIN, O.V.; SHVARTSMAN, L.A.

Refining cast iron and steel outside the furnace. Izv.vys.ucheb.
zav.; chern.met. 4 no.5:47-49 '61.   (MIRA 14:6)

1. TSentral'nyy nauchno-issledovatel'skiy institut chernoy
metallurgii.
       (Cast iron—Metallurgy) (Steel—Metallurgy)

21369

S/126/61/011/004/007/023
E111/E435

15 2220   1273, 1043, 1142

AUTHORS: Alekseyev, V.I. and Shvartsman, L.A.

TITLE: Free Energy of Formation of Some Carbides of Vanadium
and Chromium

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol.11, No.4,
pp.545-550 + 1 plate

TEXT: The authors describe their CH_4/H_2 equilibrium studies on
the systems $V_4C_3 \cdot V_2C$ and $Cr_{23}C_6$-Cr using a gas-circulation
method.   Combining these results with those for graphite, they
have found the temperature dependence of the free-energy of
formation from the metals and graphite of V_4C_3 and $Cr_{23}C_6$.   In the
literature such data for carbides are calculated from thermal
values.   The authors assume that the free energy of formation of
$VC_{0.41}$ (called V_2C) remains constant for its homogeneity range and
that the saturated solid solution of carbon in the metal can be
denoted as pure metal.   Using their previously described (Ref.1)
apparatus and method and published data (Ref.3) they obtained the
following equation for carbon solubility

$$\lg [\% C] = -\frac{11500}{4.575 \, T} - 0.61 \tag{3}$$

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S/126/61/011/004/007/023

Free Energy of Formation ...

E111/E435

In the present work, the same method (Ref.1) was used to find the free energy of formation from the elements of V_4C_3 and $Cr_{23}C_6$. The first was prepared by vacuum reaction of V_2O_3 with carbon at 1500 to 1700°C (Ref.4). Metallic vanadium was added and the mixture was heated to produce a system containing both V_4C_3 and V_2C over long periods. The $Cr_{23}C_6$-Cr material was made by heating lamp black with chromium powder (0.06% C, 0.03 N, 0.06 O, 0.05 Fe, 0.01 W, 0.03 Al) at 1450 to 1500°C in argon for 10 hours. In most experiments equilibrium was approached from the hydrogen side. The kinetics of the $C + H_2$ reaction was found, in subsidiary experiments, to be unsuitable for producing mixtures permitting an approach from the other side. The equilibrium methane pressure in a closed volume was determined after oxidation of hydrogen over copper oxide at 290 to 300°C and removal of water by freezing in liquid nitrogen. For the reaction V_4C_3 solid + $2H_2$ gas = $2V_2C$ solid + CH_4 gas it was found that

$$\triangle G^0_{973-1223°K} = -12500(\pm 400) + 28.4(\pm 1.0) T \qquad (8)$$

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S/126/61/011/004/007/023
Free Energy of Formation ...   E111/E435

Combination of this with Richardson's equation, for the graphite-hydrogen reaction giving methane

$$\triangle G^O_{500-2273°K} = 21550 - 26.16\ T \qquad (9)$$

gives for the $2V_2C_{solid} + C_{solid} = V_4C_3\ solid$ reaction

$$\triangle G^O_{973-1223°K} = -9000\ (\pm400) - 2.20\ (\pm1.0)\ T \qquad (11)$$

Combination of this with the equation for V_2C formation from the elements

$$\triangle G^O_{973-1273°K} = -11500\ (\pm600) - 0.5\ (\pm0.6)\ T \qquad (1)$$

gives

$$\triangle G^O_{973-1223°K} = -10800\ (\pm500) - 1.1\ (\pm0.7)\ T \qquad (12)$$

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S/126/61/011/004/007/023
E111/E435

Free Energy of Formation ...

for the formation of V_4C_3 from the elements for 1 g atom C. For the reaction $1/6 \ Cr_{23}C_6 \ solid + 2H_2 \ gas = 23/6 \ Cr_{solid} + CH_4 \ gas$, the equation is

$$\triangle G^O_{973-1223°K} = - 7900 \ (\pm \ 400) + 26.3 \ (\pm \ 0.4) \ T \qquad (14)$$

Combination with Eq. (9) gives, for the reaction
$23/6 \ Cr_{solid} + C_{solid} = 1/6 \ Cr_{23}C_6$,

$$\triangle G^O_{973-1223°K} = - 13600 \ (\pm \ 400) - 0.2 \ (\pm \ 0.4) \ T \qquad (16)$$

This indicates a stability lower than that given by Richardson (Ref. 5) but higher than that of either of the vanadium carbides. The latter is anomalous in view of the positions of the elements in the periodic table. The limiting solubility of carbon in solid chromium in equilibrium with $Cr_{23}C_6$ can be found as for the vanadium system. There are 4 figures, 1 table and 6 references: 4 Soviet and 2 non-Soviet.

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21360

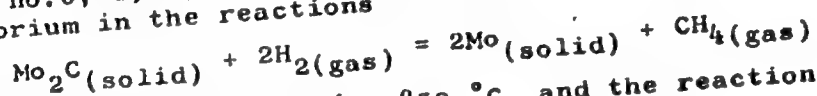Free Energy of Formation ...

S/126/61/011/004/007/023
E111/E435

ASSOCIATION: Institut metallovedeniya i fiziki metallov TsNIIChM
(Institute of Science of Metals and Physics of Metals
TsNIIChM)

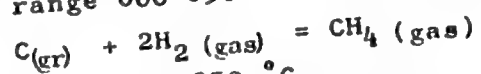SUBMITTED: July 14, 1960

Card 5/5

S/180/62/000/006/020/022
E021/E151

AUTHORS: Alekseyev, V.I., and Shvartsman, L.A.   (Moscow)

TITLE: Free energy of formation of molybdenum carbide Mo$_2$C

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Otdeleniye tekhnicheskikh nauk. Metallurgiya i toplivo, no.6, 1962, 171-175

TEXT: The circulation method described earlier (DAN SSSR, v.133, no.6, 1960, 1331-1333) was used to investigate the equilibrium in the reactions

$$Mo_2C_{(solid)} + 2H_{2(gas)} = 2Mo_{(solid)} + CH_{4(gas)} \qquad (2)$$

in the temperature range 600-850 °C, and the reaction

$$C_{(gr)} + 2H_{2\ (gas)} = CH_4\ (gas)$$

in the temperature range 700-950 °C.

Pure hydrogen (obtained electrolytically) was used. Molybdenum carbide was made by cold pressing molybdenum and carbon powders and sintering at 1500 °C for 10 hours in a purified argon
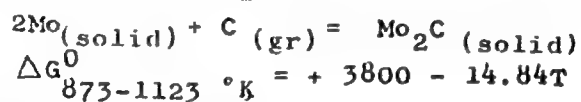
Card 1/2

Free energy of formation of ...   S/180/62/000/006/020/022
                                         E021/E151

atmosphere. For the first reaction the free energy followed the
equation

$$\Delta G^0_{873-1123\ °K} = -25350 + 41.0T.$$

The results obtained for the equilibrium in the second reaction
agreed with data of F.D. Richardson (The thermodynamics of
metallurgical carbides and of carbon in iron, J. of Iron and Steel
Inst., v.175, 1953, 45). The equation for the free energy of
formation of the carbide Mo_2C, calculated from the above, was found
to be

$$2Mo_{(solid)} + C_{(gr)} = Mo_2C_{(solid)}$$
$$\Delta G^0_{873-1123\ °K} = + 3800 - 14.84T$$

There are 1 figure and 2 tables.

SUBMITTED: May 26, 1962

Card 2/2

S/020/61/141/002/012/027
P 103/B110

15.2240

AUTHORS: Alekseyev, V. I., and Shvartsman, L. A.

TITLE: Free energy of formation of manganese carbide, $Mn_{23}C_6$

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 141, no. 2, 1961, 346 - 348

TEXT: The free energy of formation of lowest-carbon manganese carbide $Mn_{23}C_6$ was determined, and the equilibrium in the system $Mn_{23}C_6-H_2-Mn-CH_4$ was studied by a method described earlier (V. I. Alekseyev, L. A. Shvartsman, DAN, 133, no. 6 (1960)). $Mn_{23}C_6$ was obtained by sintering a mixture of metallic Mn powders and carbon black at 1050°C for 24 hr in argon atmosphere. The x-ray pattern of the sample before and after the experiment showed two phases: (a) $Mn_{23}C_6$, and (b) Mn. From the results it is concluded that the equilibrium constant $K_{eq} = P_{CH_4}/P_{H_2}^2$ of the reaction $1/6 \, Mn_{23}C_{6(solid)} + 2H_{2(gas)} = 23/6 \, Mn^+_{(solid)} + CH_{4(gas)}$ was determined in the experiments between 650 and 900°C. The function $\log K_{eq} = f(1/T)$

Card 1/4

Free energy of formation...

was found to be linear. Spread of the results is explained by intensive Mn sublimation and condensation on the cold parts of the apparatus. This causes a change in the gaseous phase composition due to CH_4 and H_2 adsorption. Furthermore, careful degassing of the sample at the required temperature is impeded by the volatility of Mn. The results were evaluated by the method of least squares, and the equations $\log K_{eq923 - 1173^\circ K}$ = $\left[4000 (\pm 380)\right]/T - 6.45 (\mp 0.45)$ and $\Delta G^\circ_{923 - 1173^\circ K}$ = $-18300 (\pm 1700)$ $+ 29.51 (\pm 2.0) T$ (3) were derived. The combination of Eq. (3) with the equation for the free energy of formation of CH_4 from C and H_2 (Ref. 8, see below) gives for the reaction $23/6 Mn_{(solid)} + C_{(graphite)}$ = $1/6 Mn_{23}C_{6(solid)}$ (4): $\Delta G^\circ_{973 - 1173^\circ K}$ = $-3300 (\pm 1700) - 3.35 (\mp 2.0) T$ (5). Hence it is concluded that the heat of formation of $Mn_{23}C_6$ (-3300 cal) is very close to that of Mn_3C. From a comparison of thermodynamic data of $Mn_{23}C_6$ (formation under heat generation) with those of Mn_7C_3 (Ref. 5, see below) the latter is assumed to be an endothermic compound.

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7-1

.../S1/141/002/012/027

Free energy of formation...   3105/B110

Explanation: In the formation of carbides of transition metals of group
IV, the d-shell of metal atoms is partly filled with valence electrons of
C atoms. The energy of the additional electrons increases during the
filling process of α-shell vacancies. Hence, the heat of carbide forma-
tion decreases as the degree of d-shell filling increases with increasing
atomic number in the order Ti $\longrightarrow$ Ni and also with increasing ratios between
the number of C atoms and that of metal atoms in carbides. In the order
Ti $\longrightarrow$ Ni, chromium is an exception since the heat of formation of $Cr_{23}C_6$

(-13,600 cal) exceeds that of V_2C (-11,500 cal). On the basis of this

anomaly, the structure of a free Cr atom presumably differs from that of
its neighbors Mn and V by containing only one electron on level 4 s (as
against 2 with Mn and V). At the same time, the d-shell of a Cr atom
contains just as many electrons as the d-shell of an Mn atom. Therefore,
it has 2 electrons more than the same shell of a V atom. Hence, it is
assumed that the covalent bond in the formation of chromium carbides is
possible by coupling one valence electron of C with the 4 s electron of
Cr. There are 2 figures and 9 references: 4 Soviet and 5 non-Soviet.
The three references to English-language publications read as follows:

Card 3/4

30701

S/020/61/141/002/012/027
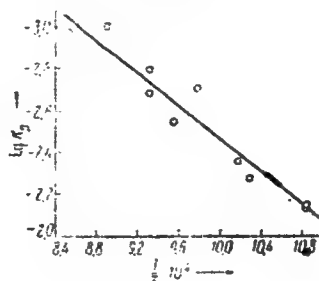B105/B110

Free energy of formation...

Ref. 2: K. Kuo, L. E. Persson, J. Iron and Steel Inst., part I, 78, 39
(1954); Ref. 5: C. McCabe, R. Hudson, J. Metals, No. 1[a] (1957); Ref. 8:
F. D. Richardson, J. Iron and Steel Inst., 175 (1953).

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy
             metallurgii im. I. P. Bardina (Central Scientific Research
             Institute of Ferrous Metallurgy imeni I. P. Bardin)

PRESENTED: June 12, 1961, by G. V. Kurdyumov, Academician

SUBMITTED: June 7, 1961

Fig. 2

Card 4/4

ACCESSION NR: AR4015650   S/0081/63/000/021/0030/0030

SOURCE: RZh. Khimiya, Abs. 21B181

AUTHOR: Shvartsman, L. A.

TITLE: Some problems in the thermodynamics of iron-based alloys

CITED SOURCE: Sb. tr. In-t metalloved. i iz. metallov. Tsentr. n.-i. in-ta chernoy metallurgii, v. 7, 1962, 345-362

TOPIC TAGS: ferro-alloy, ferro-alloy carbon activity, alloying element carbon affinity, carbon activity variation, iron based alloy

ABSTRACT: The author discusses problems relating to the behavior of low concentrations of carbon in ferro-alloys when alloying elements (AE) are introduced. Carbon acitivty at $[C]$= constant varies in the presence of AE. If the latter have a greater affinity for C than for Fe, then a carbide of the AE can precipitate when the solution is saturated. Carbon activity in the alloys was determined on a circulation unit used to study the equilibrium $C + CO_2 = 2CO$, $K = P_{CO}^2 / [\%C]$ $P_{CO_2} = r$ $[\%C]$. The activity factor γ_C varies in the presence of AE and the equilibrium constant can be written as $K = r_{AE} / [\%C]AE \cdot \gamma_C AE$. Metals to the left of Fe in the fourth row of the periodic system decrease the activity of C in fusion. Alloying
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ACCESSION NR: AR4015650

with Co, which does not form a solid carbide, increases γ_C in the solution.
Alloying with Ni also increases it. The less filled the d-phase, the greater the
affinity for C and the greater the reduction of γ_C when AE (U, Mn, Cr) are in-
troduced. The previously determined functions $\Delta F_{V_2}C = -11,500 -0.49$ T cal and
$\Delta F_{VC} = -10,300 -1.37$ T cal are cited in the article. L. Reznitskiy

DATE ACQ: 09Dec63   SUB CODE: ML, PH   ENCL: 00

Card   2/2

AUTHORS: Petrova, Ye. F., and Shvartsman, L. A.

TITLE: Determination of carbon activity in solid iron

PERIODICAL: Zavodskaya laboratoriya, v. 28, no. 11, 1962, 1334 - 1337

TEXT: A method of determining the thermodynamic activity of carbon in iron by means of C^{14} in one experimental operation on several samples is described. The experimental arrangement consists of two parts: In one part of the apparatus an iron specimen containing a certain quantity of carbon tagged with C^{14} is placed in a transparent quartz tube to serve as a standard. In the other part, annular samples of pure iron free from carbon are placed in a quartz tube. The tube containing the samples is put in a furnace. Before the experiment, both tubes are evacuated in the cold state and are then annealed at ~10^{-5} mm Hg for about 24 hrs; after annealing, the experimental setup (Fig. 1) is filled with hydrogen (300 mm.Hg), and the furnace is kept at a certain temperature. The circulation of hydrogen produces methane, the composition of which, after reaching

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equilibrium, depends only on the temperature of the standard and on the concentration of the carbon contained in it. The composition is characterized by $r = P_{CH_4}/P_{H_2}$, where P_{CH_4, H_2} are the partial pressures. r can be exactly determined by the method of R. P. Smith (J. Am. Chem. Soc., 68, 7, 1163 (1946)). The equilibrium gas mixture circulates over 10 - 12 iron samples free from carbon, so that carbon diffuses into the samples. After the experiment, the radioactivities of the standard and of the samples are compared whereby the carbon concentration in the samples is accurately determined. This supplies the data needed for finding the thermodynamic activity of carbon in the usual way, based on the reaction $[C] + 2H_{2(g)}$ = $CH_{4(g)}$ with the aid of the law of mass action. There are 3 figures and 1 table.

ASSOCIATION: Tsentral'nyy nauchno-issledovatel'skiy institut chernoy
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Card 2/𝟤 z

AUTHORS: Petrova, Ye. F., Shvartsman, L. A.

TITLE: Thermodynamics of solid solutions in the system Fe - Ni - C

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 146, no. 3, 1962, 646-648

TEXT: The results obtained by R. P. Smith (Trans. Met. Soc. AIME, 218, 62 (1960)) stating that the carbon in solid solutions of the system Fe - Ni containing ~75 atom% Ni shows a minimum of solubility at 1000°C were checked. Experiments were performed on an iron-nickel alloy containing 73.5% Ni and on pure nickel, from which the constant $K = P^2_{CO}/P_{CO_2}[\%C] = r^0_i[\%C]$ was calculated at 850, 900; 950, 1000, and 1050°C, where $[\%C]$ is the carbon dissolved in the solid solution in % by weight. It was found for pure nickel: $-RT \ln[\%C] = \Delta G^0 = 9700 - 4.95T$, while the following holds for the Fe-Ni alloy: $-RT \ln[\%C] = \Delta G^0 = 8370 - 3.60T$. The heat of solution of carbon in the Fe-Ni alloy is lower than its heat of solution in pure nickel. The decrease in entropy of dissolution of C in the alloy accounts for the decrease in solubility

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B101/B144

of C in the alloy. The cause of this decrease in entropy is an ordering
of the alloy which renders incorporation of carbon in the lattice more
difficult. There is 1 figure. The most important English-language
references are: F. Richardson, J. Iron and Steel Inst., 175, 257 (1953);
B. Fleischer, J. F. Elliott, The Physical Chem. of Metallic Solutions
and Intermetallic Compounds, Nat. Phys. Lab. Symposium, no. 9, 1,
paper 2F, London, 1959.

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PRESENTED: February 14, 1962, by G. V. Kurdyumov, Academician

SUBMITTED: February 12, 1962

Card 2/2

ALEKSEYEV, V.I. (Moskva); SHVARTSMAN, L.A. (Moskva)

Thermodynamics of the reaction of formation of tungsten carbides.
Izv. AN SSSR. Otd. tekh. nauk. Met. i gor. delo no.1:91-96 Ja-F '63.
(MIRA 16:3)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo nauchno-
issledovatel'skogo institut chernoy metallurgii.
    (Tungsten carbide)   (Thermodynamics)

ITKIN, V.I.; MOGUTNOV, B.M.; SHVARTSMAN, L.A.

Transformations due to heating of iron-nickel martensite.
Dokl. AN SSSR 161 no.5:1073-1076 Ap '65.   (MIRA 18:5)

1. Institut metallovedeniya i fizik metallov TSentral'nogo
nauchno-issledovatel'skogo instituta chernoy metallurgii im.
I.P.Bardina. Submitted November 5, 1964.

S/0279/64/000/002/0180/0185

ACCESSION NR: AP4029845

AUTHOR: Alekseyev, V. I. (Moscow); Shvartsman, L. A. (Moscow)

TITLE: Comments on the experimental data on the thermodynamics of Mo$_2$C and WC

SOURCE: AN SSSR. Izv. Metallurgiya i gornoye delo, no. 2, 1964, 180-185

TOPIC TAGS: molybdenum carbide, tungsten carbide, thermodynamics, transitional metal, metalloid, carbide

ABSTRACT: Recently, interest has grown in the study of thermodynamic properties of transitional metals, especially their compounds with metalloids and particularly carbides. The significance of the thermodynamic properties of molybdenum carbide and tungsten carbide is important for solving a number of technical problems. The authors attempt to explain the cause of the discrepancies among the data of recent research. Graphs of the temperature dependence are given as well as reaction formulas. It is shown that the direct experimental results of Gleiser's and Chipman's work on the thermodynamics of the formation reaction of Mo$_2$C (Gleiser, M., Chipman, I. Free Energy of Molybdenum Oxide and Carbide. J. Phys. Chem., 1962, vol. 66, p. 1539) confirmed the respective data presented in these authors' previous article (Alekseyev, V. I., Shvartsman, L. A. Svobodnaya energiya obrazovaniya

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karbida molibdena Mo_2C (free energy of formation of molybdenum carbide Mo_2C) Izv. AN SSSR OTN, Metallurgiya i toplivo, 1962, no. 6). The same agreement of results is found between the authors' other works (Alekseyev, V. I., Shvartsman, L. A. Termodinamika obrazovaniya karbidov vol'farama (thermodynamics of tungsten carbide formation) Izv. AN SSSR, OTN, Metallurgiya i gornoye delo, 1963, no. 1, p. 91 and Gleiser, M., Chipman, I. Free Energy of Formation of Tungsten Carbide, WC Trans. metallurgical Soc. AIME, 1962, vol. 224, p. 1278) dedicated to determining the thermodynamic characteristics of tungsten carbide formation. Orig. art. has: 19 formulas and 2 figures

ASSOCIATION: none

SUBMITTED: 10Jul63   DATE ACQ: 30Apr64   ENCL: 00

SUB CODE: ML   NO REF SOV: 002   OTHER: 007

Card 2/2

ALEKSEYEV, V.I.; SHVARTSMAN, L.A.

Thermodynamics of certain plain and mixed transition metal carbides. Probl. metalloved. i fiz. met. no.8:281-304 '64. (MIRA 18:7)

PETROVA, E.F.; SHVARTSMAN, L.A.

Determination of the thermodynamic activity of carbon in
chromium alloyed iron using radioactive C^{14}. Zhur. fiz. khim.
38 no.3:765-766   Mr '64.   (MIRA 17:7)

1. Institut metallovedeniya i fiziki metallov TSentral'nogo
nauchno-issledovatel'skogo instituta chernoy metallurgii
imeni I.P. Bardina.

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EWP(t)/EWP(b)   Pc-4/Pr-4/Ps-4/Pi-4/Pu-4   IJP(c)/RPL   JD/WW/JW/JG/AT/RM/

ACCESSION NR: AP4043553   S/0020/64/157/004/0951/0953

AUTHORS: Surovoy, Yu.N.; Alekseyev, V.I.; Shvartsman, L.A.

TITLE: The thermodynamics of complex $(Fe_xMo_y)_2C$ carbides

SOURCE: AN SSSR. Doklady*, v. 157, no. 4, 1964, 951-953

TOPIC TAGS: complex iron molybdenum carbide, $(Fe_xMo_y)_2C$, thermody-
namics, relative partial free energy, heat content, entropy, $(Fe_{0.02}Mo_{0.98})_2C$, $(Fe_{0.036}Mo_{0.964})_2C$, $(Fe_{0.05}Mo_{0.95})_2C$, carbon transi-
tion

ABSTRACT: The thermodynamics of $(Fe_xMo_y)_2C$ were investigated by
determining the equilibrium between the carbides and gaseous mixtures
of hydrogen and methane: $C(in\ carbide) + 2H_2(g) \rightarrow CH_4(g)$. The car-
bides were synthesized by heating pressed mixtures of the iron
carbonyl, molybdenum and lamp black under vacuum at 1400C for 10 hours.
Measurements were made by the circulation method described earlier
by Alekseyev and Shvartsman (DAN, 133, No. 6, 1331 (1960)). X-ray
analysis showed the 3 samples had an Mo_2C structure. Expressions
were derived for the relative partial free energies of the carbon

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in the carbides ($\Delta G_C = \bar{G}_C - G$ graphite $= RT \ln a_C$), where a_C is the activity of the carbon in the carbides with reference to graphite, $a_C = r/r$; $r = P_{CH_4}/P_{H_2}^2$ was determined experimentally, and $r^\bullet$, the equilibrium of $CH_4 - H_2$ gas mixtures with pure graphite, was obtained from the literature. For $(Fe_{0.02}Mo_{0.98})_2C$, $\Delta\bar{G}_C = -2360 - 9.66T$ (873-1123K); for $(Fe_{0.036}Mo_{0.964})_2C$, $\Delta\bar{G}_C = -2610 - 9.56T$ (873-1123K) and for $(Fe_{0.05}Mo_{0.95})_2C$, $\Delta G_C = -9090 - 3.10T$ (873-1123K). The first term in these equations represents the relative partial heat content of carbon, ΔH_C, and the coefficient of temperature represents the relative partial entropy ΔS_C in the given temperature interval. Increasing the iron content in these complex iron-molybdenum carbides changed the thermodynamic characteristics of the carbon; increasing the iron increased the exothermic nature of the transition of the carbon from graphite to carbide; the entropy of the carbon in the carbide is reduced. Analgous effects of iron were observed in $(Fe_xCr_y)_{23}C_6$ type carbides. No explanation for these unexpected results is given.

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ACCESSION NR: AP4043553

Orig. art. has: 2 tables and 9 equations.

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SUBMITTED: 29Feb64   ENCL: 00

SUB CODE: TD, GC, IC   NR REF SOV: 001   OTHER: 001

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